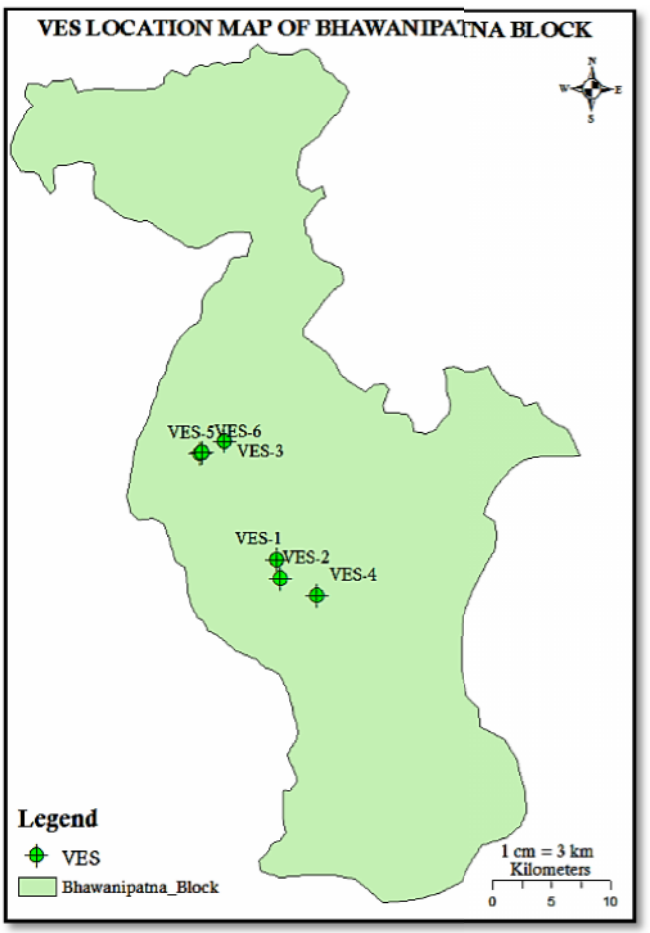
REPORT NO. ARO-RNC/GWI/AROBBSR/2017/227

# GROUNDWATER INVESTIGATION REPORT

## around Bhawanipatna Block of Kalahandi district, Odhisa for drinking purpose [Tube Well Site, 06 Locations]




**Period of Investigation: 13-16/01/2017, Field Area Visit: to 17-19/01/2017**


*Implementing Organization*

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Action For Food Production

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# Acknowledgement:

I am very much thankful to expresses my gratitude to Mr. D. K. Manavalan, Executive Director, AFPRO, New Delhi for providing me a great opportunity to work in the project area around Bhawanipatna Block of Kalahndi district of Odhisa, Eastern Ghats granitic/lateritic terrain in an excellent Geological and Hydrogeological interest.

The author extends his wholehearted thankfulness for his kind help and cooperation provided by **Mr. Loknath Mohanty**, Regional Manager of AFPRO Regional Office, Bhubaneswar, during the period of Groundwater Investigation work and during whole tour travel plan and management. I would like to give a great thanks to **Mr. Ranjit Mohanty**, Technical Assistants and **Mr. Pratap Sahu**, Driver cum Technical Assistant for providing help and support during the investigation work, without which the work could not be succeeded. Thanks go to all other staff of Project Office, Bhawanipatna for their good behavior and hospitality during the field visit.

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I wish to extend my indebtness to **Mr. Ajit Kumar**, Regional Manager of AFPRO Regional Office, Ranchi for program planning and management for the field visit of ARO, Bhubaneswar.

Last but not the least I thankfully acknowledge to all other people who co-operated & helped directly or indirectly during the whole work.

With best regards & wishes for the consecutively running of the project and good future endeavor at all.

Pradeep Kr. Oraon

***Dr. Pradeep Kumar Oraon***
***Sr. Hydrogeologist***
***AFPRO, Regional Office, Ranchi***

# Contents

**REPORT NO. ARORNC/GWI/AROBBSR/2017/227**

# GROUNDWATER INVESTIGATION

## Tube Well Site, 06 Locations-Drinking Purposes

### 1. INTRODUCTION:

Request received from AFPRO, Regional Office, Bhubaneswar, to conduct Groundwater Investigation to find out the feasible/suitable sites for drilling bore wells for installation of Hand Pumps for safe drinking water for the community. The present project is funded by HDFC bank to enhance the living standard of the rural people by holistic approach, planning and management. Groundwater Investigation is conducted during 13-16/01/2017 by jointly incorporation of the regional office, Ranchi and Bhubaneswar. During the period of 17-19/01/2017 visited all other project villages to observe and analyze the situation for better planning and development.

| | | |
|---|---|---|
| **Funding Agency** | : | HDFC Bank |
| **Project Implementing Organisation** | : | AFPRO Regional office, Bhubaneswar |
| **Study Conducted by** | : | Jointly conducted with AFPRO, Regional Office, Ranchi |
| **Represented by ARO Team** | : | Mr. Loknath Mohanty, Hydrogeologist<br>Regional Manager, ARO- Bhubaneswar, Orissa<br>Mr. Ranjit Mohanty & Mr. Pratap Kr. Sahoo<br>Technical Assistants, ARO- Bhubaneswar, Orissa |
| | : | Dr. Pradeep Kr. Oraon<br>Hydrogeologist, ARO, Ranchi, Jharkhand |

### 1.1. Beneficiary:

Mostly Oria tribals are living in the project villages. More than 150 family/700 people will be getting safe drinking water from the installed hand pumps.

### 1.2. Location & Accessibility:

Project villages are located around **Bhawanipatna block** of Kalahandi district in Odhisa. The area of ground water investigation is located approximately 10 to 20 kms away from the Bhawanipatna and is connected partly by metalled, non-metalled and cart track road.

**Kalahandi** is one of the economically backward district of western Orissa with a geographical area of 7920 Sq. Km and is an integral part of Western Orissa Development Council constituted by Govt. of Orissa very often reels under severe drought condition. About 92.5% percent of the population of the district live in rural areas and agriculture is the main stay of the people. The agriculture is mostly rainfed and due to lack of adequate irrigation facilities and recurring severe drought conditions in the district, the agricultural production is very often curtailed. In the year 1974, 1998, 1999 the district witnessed an unprecedented drought situation.

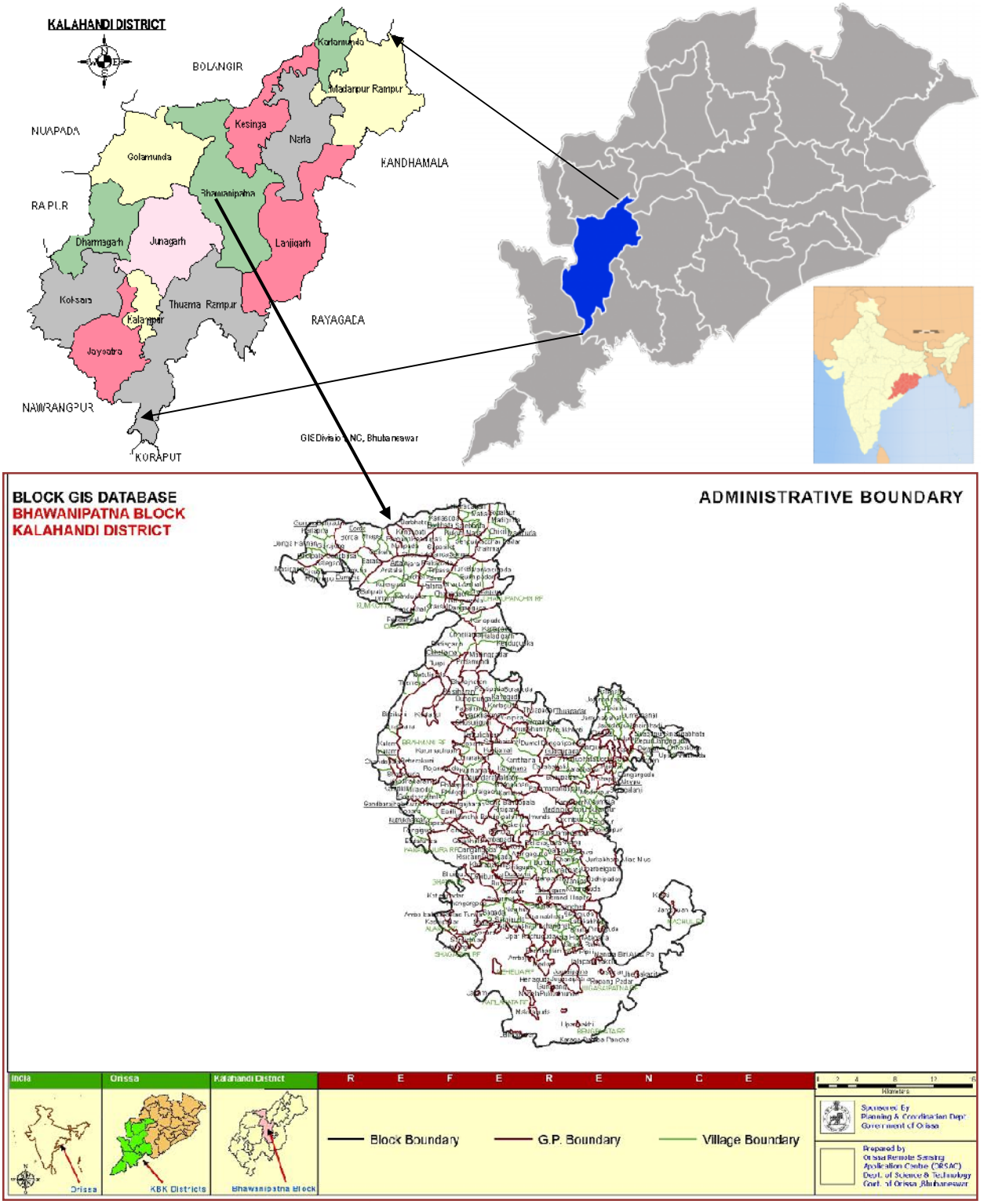



Fig.1. Location map of Bhawanipatna block of Kalahandi district.

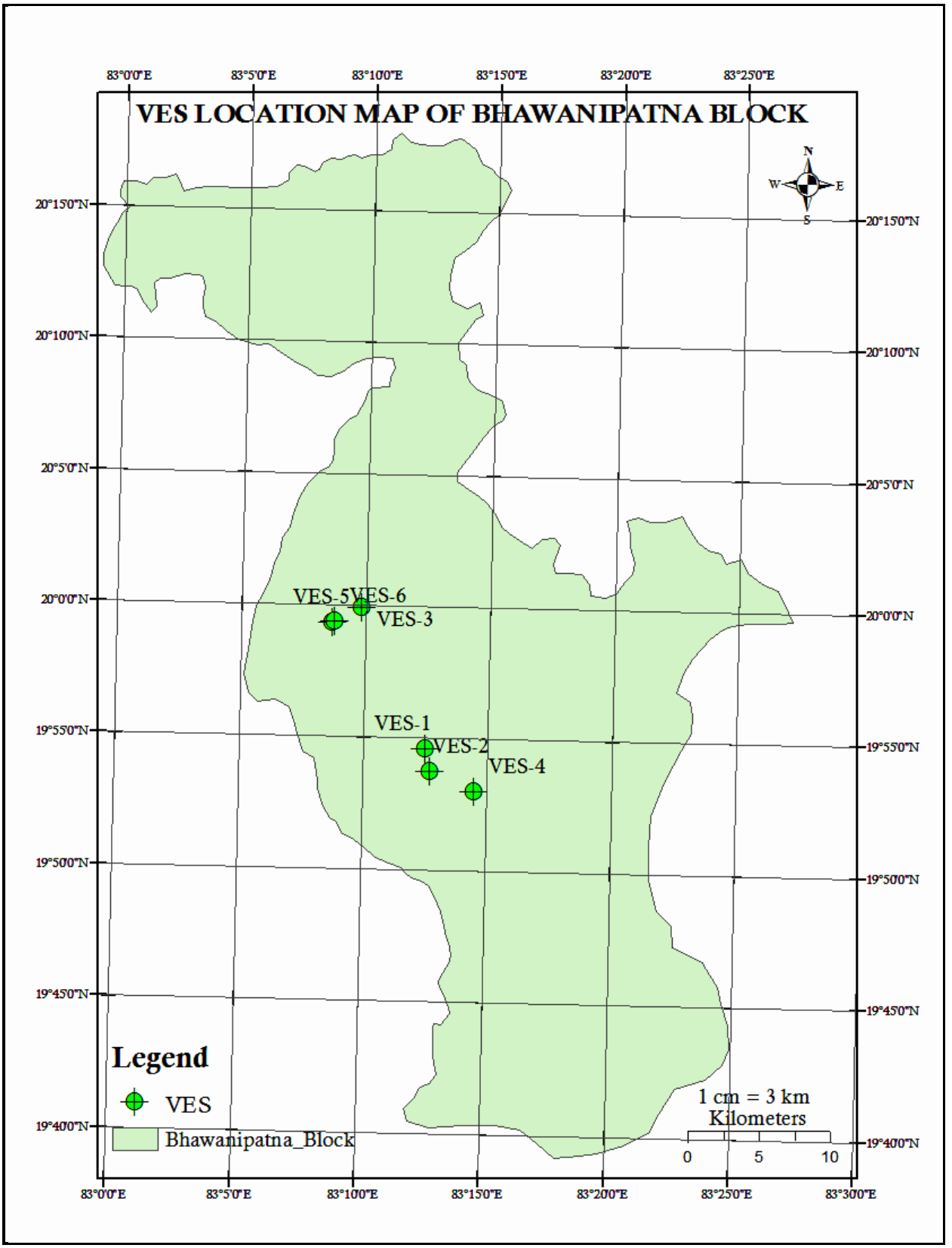



Fig.2. VES Location map of Bhawaniopatna block of Kalahandi district.

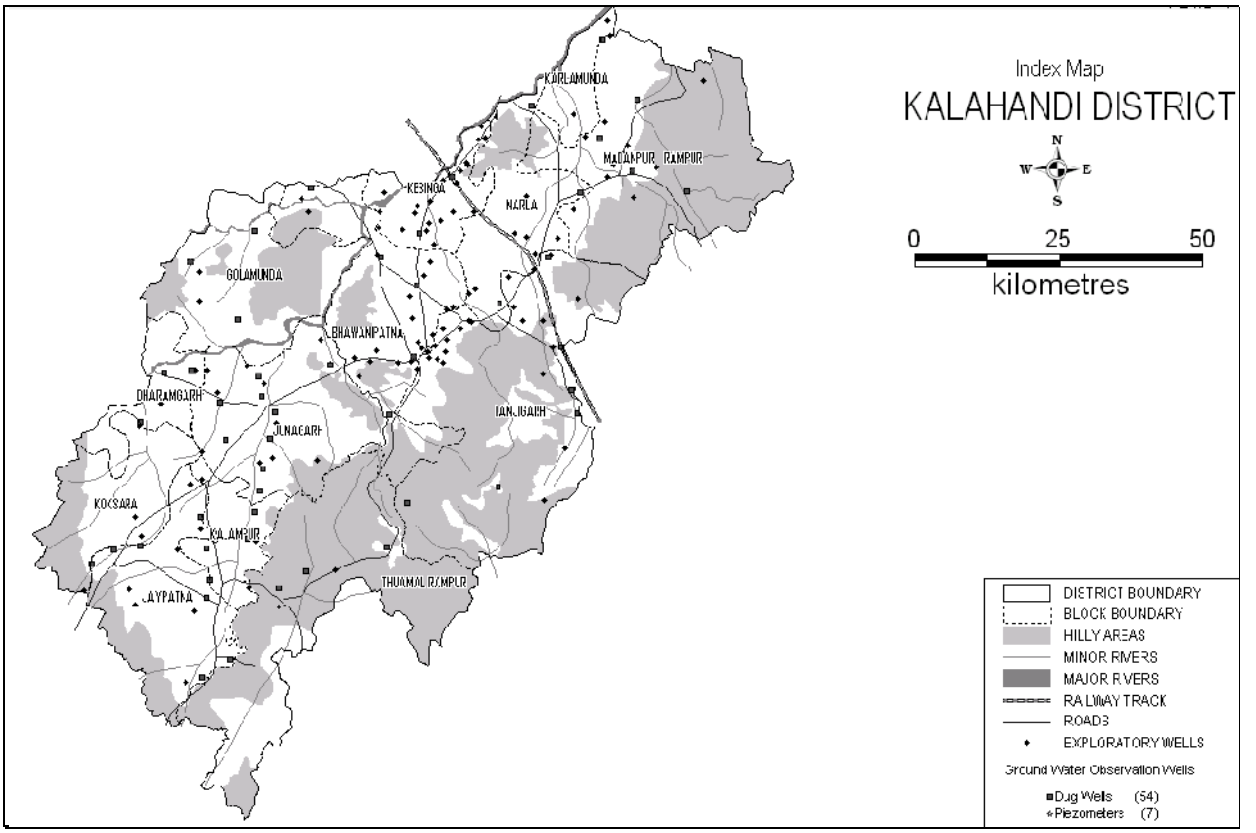


Fig. 3. Physiographic map of Kalahandi district.

## 2. GEOGRAPHY

Kalahandi district lies between North latitudes 19°03' and 20°45' and East longitudes 82°18' and 83°48', falling in Survey of India toposheet nos. 64 L, 64P, 65 I and 65 M. It is bounded on the north by Balangir and Nuapada districts, on the east by Phulbani district, on the south by Koraput district and on the west by Nawarangpur district of Orissa and Raipur district of Chhattisgarh. The district is well connected by rail and roads.

The district headquarters is at **Bhawanipatna.** The river **Tel** and its tributaries constitute the main drainage system in the district. Other notably rivers are Indravati, Udanti, Hati, Utei, Sagada, Rahul, Nagabali, Mudra, etc.

## 3. GEO-MORPHOLOGY:

### 3.1 Topography

The study area is generally considered to be undulating topography with little forest, vegetation and the area is devoid of plain of schistosity. Physiographically the district comprises diverse landforms consisting of rugged hill ranges, plateaus, undulating plains dotted with residual hills and mounds and fertile erosional plains and valleys. A gently undulating terrain with a vast stretch of cultivable land characterizes the major parts west of **Bhawanipatna** in the district. The elevation of the hills located in the southeastern and southern parts ranges from 953 to 1229 m above mean sea level. Kalahandi is surrounded by

hills. In Bhawanipatna – Utkela – Kesinga tract the elevation of land surface ranges from **186 m to 350 m** above MSL with occasional isolated hills. In the undulating plains the general topographic slope is towards northeast. About eight kilometers south-east of Bhawanipatna commences the mountain tracts called Dongri which covers a vast area of about 3665 sq. kms. on the eastern side of the district and extend southwards to the Koraput border. These tracts rise in a series of precipitous hill ranges from the plains.

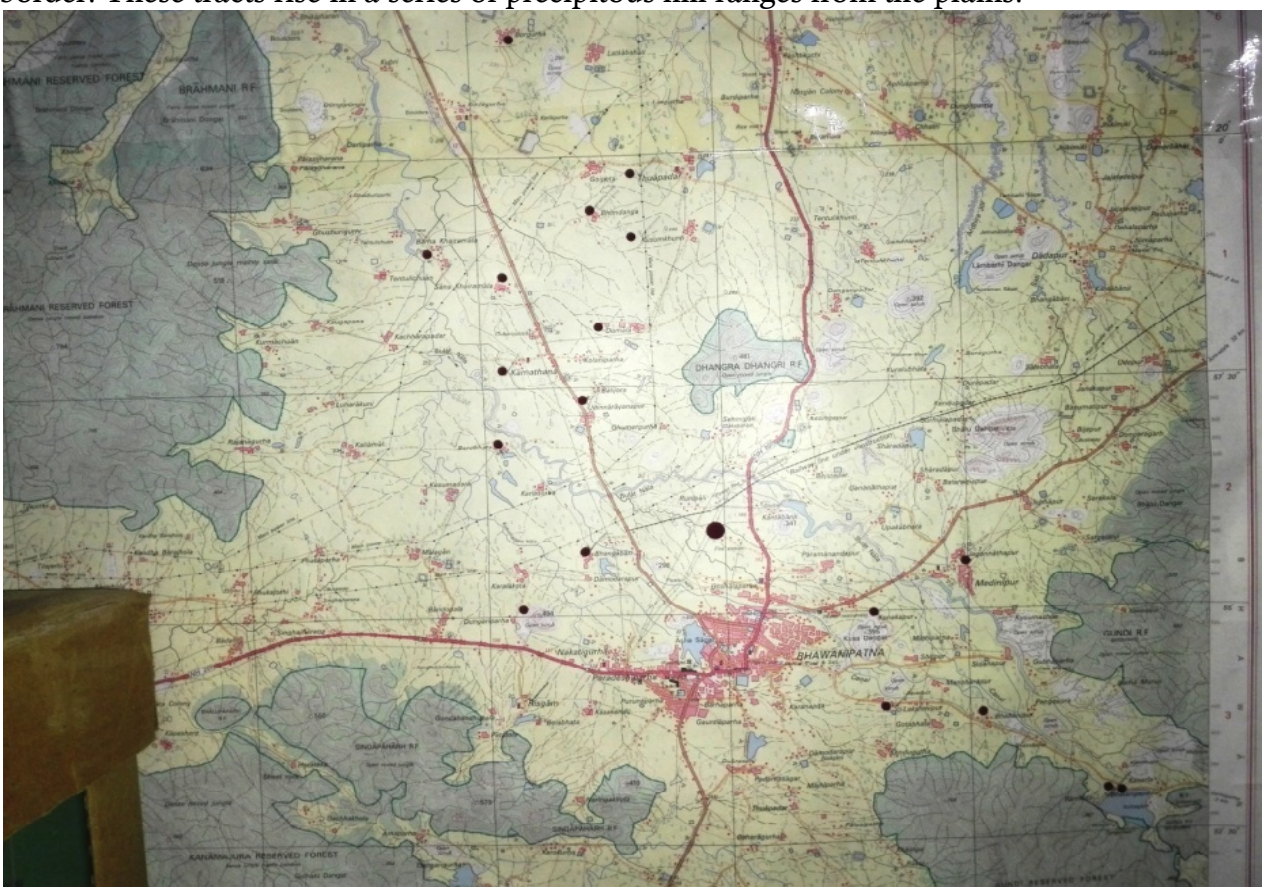



Fig.4. Toposheet of Bhawanipatna, Kalahandi district

### 3.2 Climate and rainfall

The climate of the District is of extreme type. It is dry except during monsoon. There are large varieties of day and night temperature. The summer seasons starts from the beginning of March. May is the hottest month when the maximum temperature is about $45^0$ C ($82^0$F). The temperature drops down with the onset of monsoon towards the second week of June and throughout the monsoon the weather remains cool. December is the coldest month, as the mean daily minimum temperature is recorded at 11 degree C. Relative humidity is generally higher from June to December. It's varies from 27% to 70%.

The average annual rainfall of the **district** is **1378.20 mm**. Where as the average annual rainfall of the **state** is **1502.5mm**. Nearly 86% of the annual rainfall is contributed by the southwest monsoon. The variation in the rainfall from year to year is not large. The monsoon starts late in June and generally lasts up to September. 90% of the rainfall received from June to September. August is the month with more number of rainy days. About 28% of rainfall is received during this month. Drought is normal feature of this district.

### 3.3 Soil

The major part of the area is covered by black cotton & loam types of transported and debris soil. The thickness of the soil layer is around 2 to 5 meter.

**The district has five types of soils broadly classified as below:**

a. The red lateritic soil which is different in phosphorus and nitrogen is found all over the district. Mostly under the feet hill and hillocks.
b. Sandy loam soil is seen in Lanjigarh and of the Bhawanipatna Tahasil.
c. Alluvial sandy and sandy loam soil found in the area on the river banks.

*Fig.5. Blck Cotton Soil*

*Fig.6. Loamy fertile soil*

Black soil is an important soil type in the district occupying parts of Bhawanipatna, Narla, Kesinga, Dharamgarh, Golamunda and Koksara blocks. These soils are rich in potassium and nitrogen but poor in phosphorus. These soils are most favourable for cotton cultivation which is a generally draught resistant, labour intensive but a highly remunerative crop.

### 3.4 Agriculture

Paddy, wheat and maize are the main crops and vegetables, linseed, khesari are the other crops grown in the district.

*Fig.7. Vegetable cultivation at village Kanakpur*

*Fig.8. Chilly and Cauliflawer*

## 4. GEOLOGY

Major part of the district is underlain by rocks belonging to Eastern Ghats group comprising granite gneiss, khondalite, charnokites and quartzites. The quaternary alluvium occurs in discontinuous pockets of river channels. The most predominant rocks occurring in the district are porphyritic granite gneiss these rocks are grey to grayish white in color. The Part of Kalahandi district, where the ground water survey work is undertaken is having undulating topography and having porphyritic granite gneiss as base rock.

## 5. HYDROGEOLOGY

The consolidated formation (hard rock) mainly granite gneiss, forms the main hydro-geological unit. These rocks lack primary porosity and are rendered porous and permeable by weathering and fracturing. The water yielding capacity of these rocks entirely depends on the intensity of fracturing and weathering. The ground water occurs in phreatic condition in the weathered zone and under semi- confined to confined condition in deeper fracture zones.

Groundwater occurrences, movement and recharge to aquifers are controlled by the degree of weathering, fracture pattern, geo-morphological setup and various climatic factors. Weathered and fractured granite gneiss constitutes major aquifers in the project area. Ground water is present in the weathered and fractured granite zone above compact base of granite rock. Observations of open wells of the area shows comparatively low water level, the water is available in the upper weathered granite which could be easily trapped by digging dug wells or shallow wells.

The hydrogeological framework of the district is mainly controlled by the geological set up, rainfall distribution and the degree of secondary and primary porosities in the geological formations for storage and movement of ground water. Since major parts of the district are underlain by hard rocks of diverse lithological composition and structure, the water bearing properties of the formations also vary to a great extent. The area has undergone several phases of intense tectonic deformations which has been responsible for the development of deep seated intersecting fracture system. Hydrogeological surveys in the district reveals the lithological characteristics and the role of tectonic deformation on the occurrence and distribution of ground water reservoirs and their water bearing and water yielding properties. Lineaments formed due to tensile deformation were picked up from remote sensing studies. The structural elements mainly control the occurrence and movement of groundwater in the typical fractured crystalline basement terrain.

**The major hydrogeologic units in the district can be subdivided into two broad groups:-**

(i) Areas underlain by fractured, fissured and consolidated basement rock formations.
(ii) Areas underlain by recent unconsolidated alluvial formations.

**Water bearing properties of the consolidated formations:** The crystalline rocks like granite gneisses, khondalites, charnockites, quartzites, which are devoid of primary porosity, occupy about 95% of the area of the district. The weathered residuum and jointed & fractured portion of these consolidated rocks constitute principal water bearing horizons.

The thickness of the weathered zone is generally more in the topographic lows and undulating plains than in the high land areas. Ground water occurs under phreatic condition in the weathered zone and in semi-confined to confined condition in deeper fractured zones. The water yielding capacity of fractured rocks largely depends on the extent of fracturing openness and size of fracture and nature of their interconnections.

**Granites and Granite Gneisses:** These are the most predominant rock types in the district occupying undulating terrain and topographic lows. On weathering these rocks yield sandy residuum and the intensity of weathering is controlled by the presence of open joints and foliations. Joints and fractures are well-connected creating free circulation of ground water. In general these rocks can sustain yield between 3 and 18.6 lps depending on topographic setting, thickness of weathered residuum, number of saturated fracture zones encountered and their interconnection as inferred from the ground water exploration carried out by CGWB in the district. The weathered zones in the granite gneisses can be developed through open wells and bore wells.

**Khondalites:** The Khondalites, in general occupy the hills and have limited ground water development potentials except when they occupy low laying areas. Due to well-foliated nature of these rocks, weathering is quite deep in low laying areas. These rocks are also well jointed. The thickness of the weathered zone ranges from 12 to 20 m. Ground water development potential of these rocks is meagre except in low laying areas. The yield of the bore wells ranges from 1 to 4 lps as revealed by the ground water exploration carried out by CGWB in the district.

**Charnockite:** In these rocks weathering is not pronounced and foliations and joints are not well developed. These rocks are mostly hard, compact and massive. The thickness of weathered zone ranges from 6 to 10 m. Due to hard and compact nature of the rocks ground water development prospects in the charnockite is not good and the yield from the bore wells is very poor.

**Pegmatite and Quartz veins:** These are coarse grained and hard. These form good aquifers when fractured and friable.

**Khondalites:** These rocks generally form steep linear ridges hence don't form potential aquifers. Well foliated nature of these rocks allows deep weathering. In the pediment areas, the thickness of weathering is varying from 5 to 32m. Ground water occurs under water table condition in the weathered zone and circulates through deeper fractures. The yield of bore wells range from 1 to 5 lps. The specific capacity of the dug wells ranges from 2.3 to 13.3 lpm/m.

**Charnockite:** These formations are of very much restricted occurrences in the district. Due to paucity of joints and fractures the thickness of weathering in these formations is limited up to 10m. Due to the compact nature and less weathering, ground water prospects in charnockites are not good.

**Gabbro – Anorthosites:** The rheologic property of these rocks resembles with charnockite, Barring few locations dismal weathering and lack of fracturing renders these formation as a bad water yielder. The Sp. Capacity of dug wells in anorthosite vary from 16 to 102 lpm/m drawdown.

**Quartzites:** This unit also less fractured and weathered hence do not form good aquifers. However fractured quartzites along lineaments yield good amount of water.

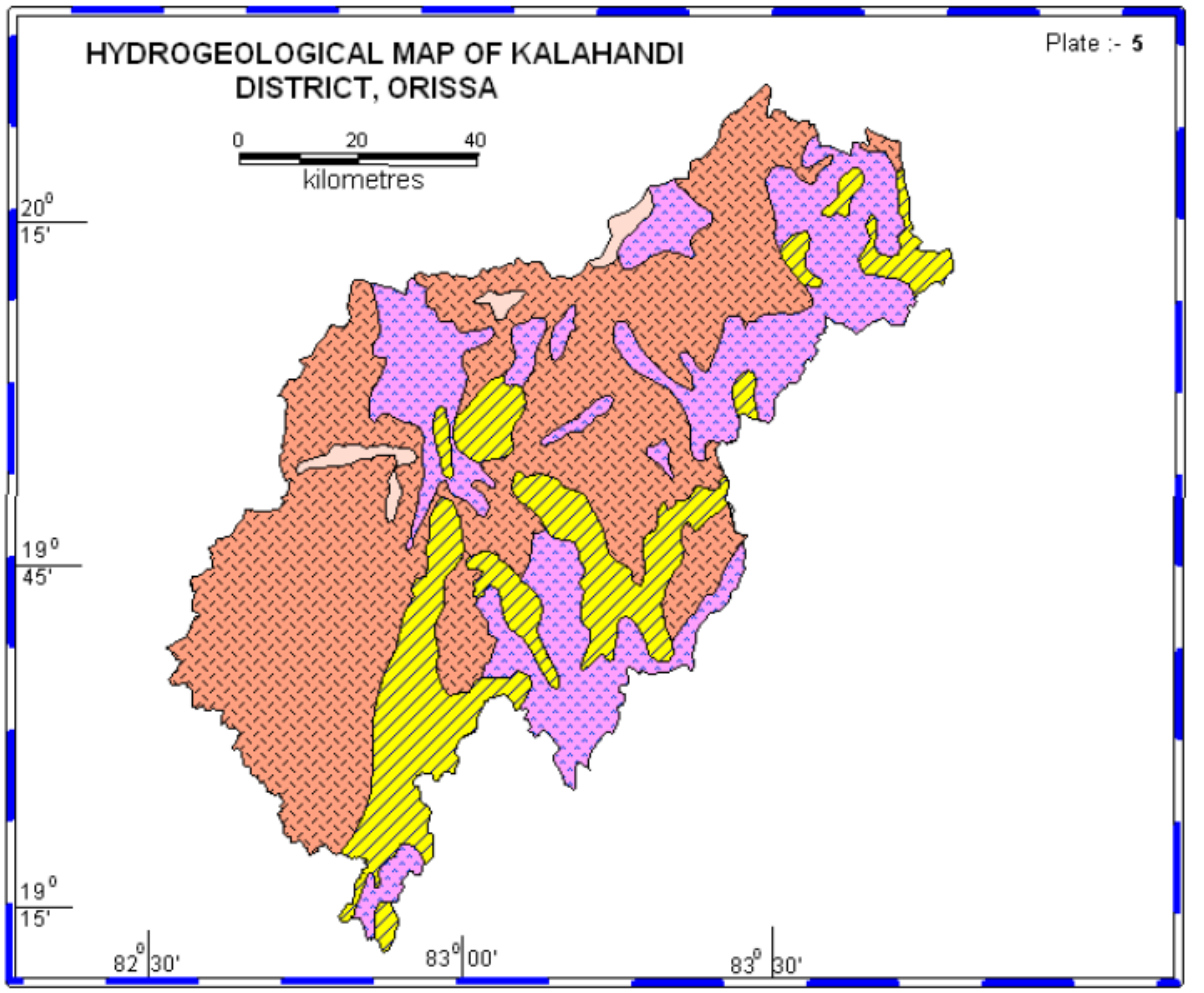
**Pegmatite and quartz vein:** These are course grained intrusives and form good aquifers when fractured.

**Water bearing properties of the unconsolidated Formation:** Laterites belonging to the Pleistocene age and alluvium of Sub-recent to Recent age constitute the unconsolidated formations in the district.

**Laterites and lateritic gravels:** Laterites of both high and low level environments occur extensively in the district forming capping over the older formations. Laterites occurring as capping over older formations are vesicular, ferruginous and highly porous in nature and at places form good near surface aquifers to be tapped through dug wells. Ground water generally occurs under phreatic condition in the shallow zone.

**Alluvial deposits:** The alluvial sediments of recent origin occur as thin discontinuous patches along the prominent drainage channels and form prolific aquifers under favourable conditions. Of particular interest are the alluvial deposits occurring as discontinuous patches in the flood plains of major rivers such as Tel, Udanti, Ret and the alluvial fan deposits in Indravati, Nagavalli and Vansadhara sub basins. The thickness of alluvial deposits varies from 10 to 30 m in the Indravati and Tel sub basins. These mainly consist of silt, sand with gravel and clay and form potential shallow aquifers. Ground water occurs under phreatic condition and the water table flies at shallow depths. These deposits are very suitable for ground water development through dug wells and shallow tube wells. Yield of tube wells in the alluvium varies from 5 to 10 lps for drawdown ranging from 5 to 8 m.

**Aquifer Characteristics of Crystalline:** In the hard crystalline rock recharge of ground water from precipitation or seepage from surface water bodies percolate into the weathered (saprolite) zone. In case the 8 underlying basement rocks (both weathered and fresh) are incised by open fractures, the downward movement of the water from the upper regolith zone (comprising the top soil and saprolite horizon) is facilitated. In the saprolite/ regolith horizon ground water generally occurs under unconfined condition where as is the fractured bedrock aquifers it occurs under semi-confined to confined conditions. The ground water potentials of various zones i.e. saprolite (tapped by dug wells), weathered basement rock and shallow fractured basement rock horizon (tapped by the hand pumps) and deeper fractured basement rock (tapped by the deep boreholes by CGWB) vary considerably depending upon their lithological and structural characteristics.




## 5.1 Groundwater Utility:

**IM-II Hand Pumps** are commonly uses for utilization of groundwater source, available in the project area. Depth of dug wells varies between 20-30 ft b.g.l, in some villages has been observed. The depth of water level varies between 15-35 ft. b.g.l in the well and depleted day by day. In this case the deep well Hand Pumps are the suitable measure to utilize groundwater for drinking purpose.

*Fig.9. Dug well used for irrigation purpose*

*Fig.10. Drip Irrigation by community for saving water*

*Fig.11. Hand pump - used for drinking water*

*Fig.12. Irrigation bore well, 1hp Submersible pumps with 1.25" delivery pipe*

**5.2 Water resource**:

A natural stream is flowing from the hill to valley region in the area. A waterfall is also flowing in the village area 6 km away from Kinkhola village.

**5.3 Ground Water Related Issue and Problems**:

Ground Water Depletion is the major problem. Some of the Hand Pump fails to extract water in the summer due to depletion of groundwater. In some village area fluoride contamination is also analyzed.

**5.4 Recharge of Groundwater:**

To maintain the ground water table of the area, artificial recharge system, Roof Top Rain Water Harvesting, Innovative Recharge pit structures etc. can be applied. This artificial recharge will also help in increase in storage and also in improving the quality of water etc. The most feasible artificial recharge and rain water harvesting structures are percolation tanks, nala/contour bunding, small check dams/weirs, renovation of old tanks to percolation tanks, subsurface dykes, water spreading, gully plugging, gabion structures etc.

### 5.5 Scope of Ground Water Development:

**Table1. Stage of Ground Water Development, as on 31st March, 2009, CGWB (in ha m)**

| Sl | Assessment Unit/ | Net Annual Ground Water Availability | Existing Gross Ground Water Draft for irrigation | Existing Gross Ground Water draft for domestic and industrial Water Supply | Existing Gross Ground water draft for all uses | Allocation for domestic and industrial requirement supply up to next 25 years | Net Ground Water availability for future irrigation Development | Stage of Ground Water Development {(6/3) *100}% |
|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| 1 | Bhawanipatna | 6412 | 1358 | 529.00 | 1887 | 1204 | 3850 | 29.43 |

## TECHNICAL INTERVENTION BY AFPRO:

### 6. HYDRO-GEOLOGICAL INVESTIGATION:

The hydro-geological investigation includes the observation of local geological set-up and the Hydro geological properties of rocks such as recharge rate; well yielding capacity; pre monsoon and post monsoon fluctuations; behavior of wells; attitude of rock formations, folds, faults, joints, lineation and foliation patterns, thickness of over burden; etc are taken into consideration.

### 6.1. Well Inventory Data

Depth of water level in open wells varies between 3m to 10m b.g.l. Different hydro geological and litho-logical strata found in different villages. The well inventory data indicates the moderate yield of ground water condition and recharge of the area. Water quality testing is required time to time for safe drinking water.

Table 2. Pre mon - post mon water level data

| BLOCK_NAME | LATITUDE | LONGITUDE | SITE_NAME | PRE MON Water_Level | POST MON Water_Level |
|---|---|---|---|---|---|
| LANJIGARH | 19°49'2" N | 83°25'55" E | Biswanathppur | 8.45 | 4.25 |
| BHAWANIPATNA | 19°51'57" N | 83°9'32" E | Attanguda | 6 | 1.74 |
| BHAWANIPATNA | 19°55'39" N | 83°6'50" E | Malgaon | 6 | 1.78 |
| BHAWANIPATNA | 19°49'0" N | 83°7'15" E | Dalguma | 10.3 | 6.2 |
| BHAWANIPATNA | 20°3'46" N | 83°6'24" E | Karlapada | 4 | |
| LANJIGARH | 19°51'10" N | 83°25'15" E | Pokaribandh | 4.5 | 1.35 |
| LANJIGARH | 20°3'45" N | 83°22'59" E | Narla | 7 | 5.32 |
| BHAWANIPATNA | 20°10'15" N | 82°59'24" E | Sargigora | 8 | 6.61 |
| BHAWANIPATNA | 20°1'4" N | 83°9'54" E | Pastikudi1 | 3.2 | 3.65 |
| BHAWANIPATNA | 19°54'29" N | 83°9'33" E | Bawanipatna | 8 | 4.95 |
| Source: CGWB, BBSR, Odhisa | | | | 30/04/2016 | 10/11/2015 |

## 7. GEOPHYSICAL INVESTIGATION:

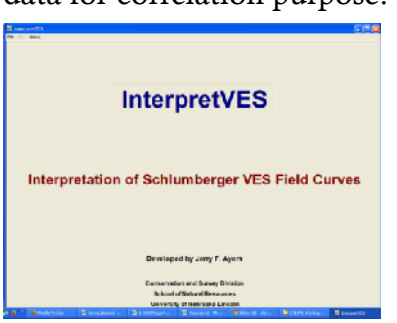
Geophysical method used in investigations was conducted by using the ABEM TERRAMETER-SAS 300B and AQUAMETER CRM-500 instrument through electrical resistivity method. The method used for investigation is **"VERTICAL ELECTRICAL SOUNDING"** by **"SCHLUMBERGER CONFIGURATION"**. In this method, the centre of the electrode spread remains fixed and the spacing between the electrodes is progressively increased until the maximum depth is reached. By way of conducting such soundings the different litho layers beneath the earth were probed to understand the thickness and apparent resistivity of different layers and its water holding capacities. It was conducted to exactly know the ground water dynamics of the area.

Electrical resistivity techniques measure earth resistivity by passing an electrical current into the ground and measuring the resulting potentials created under the earth. This method involves the supply of direct current or low-frequency alternating current in to the ground through a pair of *current electrodes* and the measurement of the resulting *potential* through another pair of electrode called *potential electrodes.* Since the current is known and the potential can be measured, an apparent resistivity can be calculated. For Schlumberger soundings, the apparent resistivity values ($\rho$) where plotted against half current electrode separation (AB/2) on a log-log graph and a smooth curve was drawn for each of the sounding. Then, the sounding curves were interpreted to determine the true resistivities and thickness ($h$) of the subsurface layers. The resistivity of the subsurface materials observed is a function of the magnitude of the current, the recorded potential difference and the geometry of the electrode array used. The depth of penetration is proportional to the Schlumberger array which uses closely spaced *potential electrodes* and widely spaced *current electrodes*. In general, the depth of infiltration is small in this method and only shallow subsurface layers have been surveyed.

A total number of 6 Vertical Electrical Sounding (VES) with maximum *current electrode* spacing 120m were used in order to evaluate the geo-electrical setting of the project area. The *potential electrode* spacing was probe to maximum 20m.

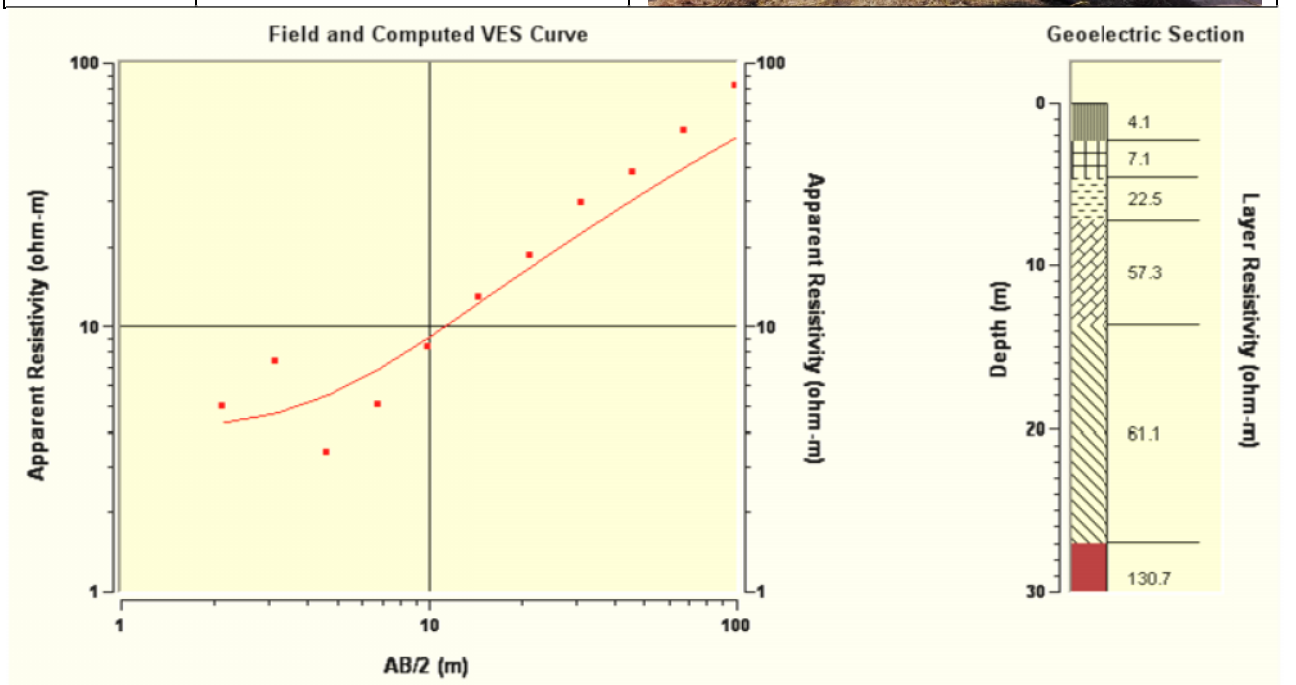
### 7.1. Interpretation of field data:

The field data are plotted in bi-logarithmic graph sheets and are matched with standard curves using partial curve matching techniques to derive the data of water bearing formation. The bi-logarithmic graph sheets is used to interpret and to draw profiles of electrical soundings, including of data extracted from resistivity tomography taken in the field. Interpret VES software is used to interpret the data for correlation purpose.

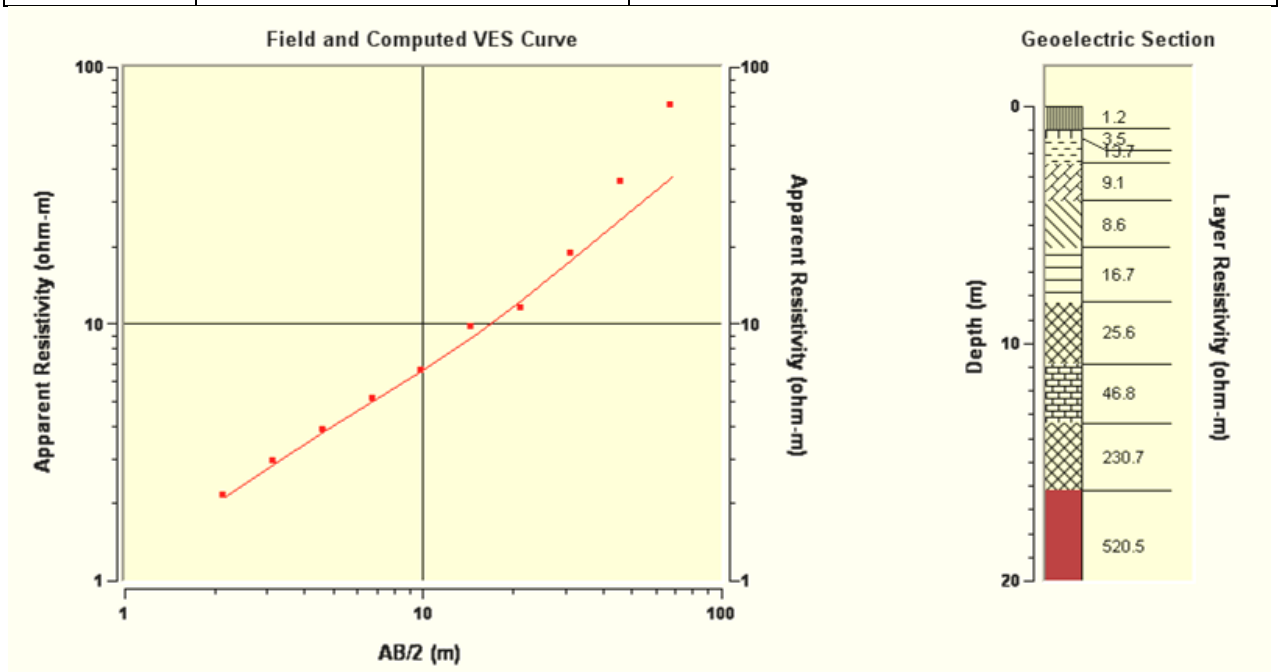
**7.2.** Details of VES (Vertical Electrical Sounding) and manual interpreted data by using bi-logarithmic graph sheets are given below:

| | |
|---|---|
| **VES No.** | **01** |
| Gram Panchayat | Siripur |
| Village | Kanakpur-Harijan Pada |
| Place | In land of Parthav Nayak |
| GPS Location | N $19^0$ 54' 37.51"<br>E $83^0$ 12' 31.86" (242m) |
| Beneficiaries | 30 Families |



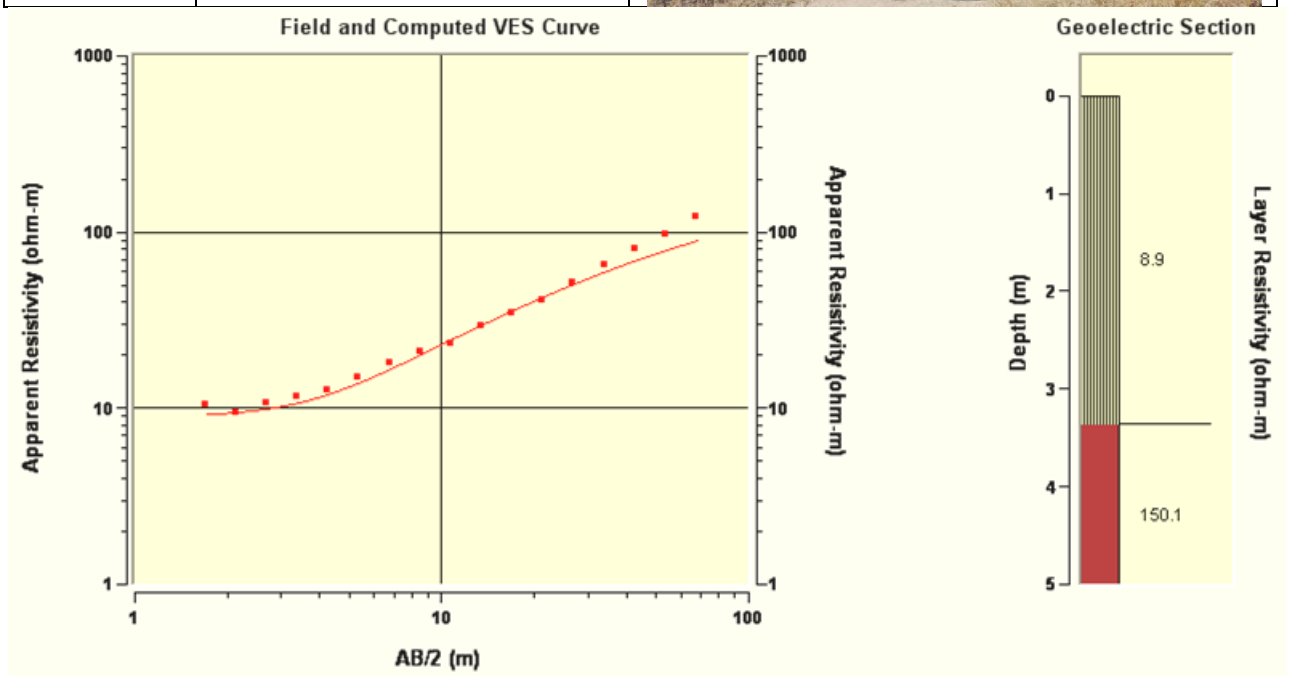

| VES No.01. Interpretation by log log sheet | | | | |
|---|---|---|---|---|
| **Resistivity (Ohm-M)** | **Thickness (M)** | **Depth (M)** | **Formation** | **Litholog** |
| 23.8 | 1.5 | 00 | Top soil | |
| 15.47 | 12 | 1.5 | Moist clay with pebbles | |
| 105 | 18.2 | 13.5 | Saturated weathered/fractured gneiss | |
| 322 | - | 31.7 | Semi Weathered or un weathered granite gneiss rock | |
| - | - | - | Massive hard rock granite | |
| Total Depth | | 31.7 | | |
| **Recommendations:** Moderate aquifer for drinking purpose. Expected depth of drilling is at about 50±5 m. | | | | |

| | |
|---|---|
| **VES No.** | **02** |
| Gram Panchayat | Medinipur |
| Village | Katyanipur |
| Place | In land of Jogeswar Manjhi /Kashi Manjhi |
| GPS Location | N $19^0$ 53' 45.22"<br>E $83^0$ 12' 44.48" (243m) |
| Beneficiaries | 30 Families |



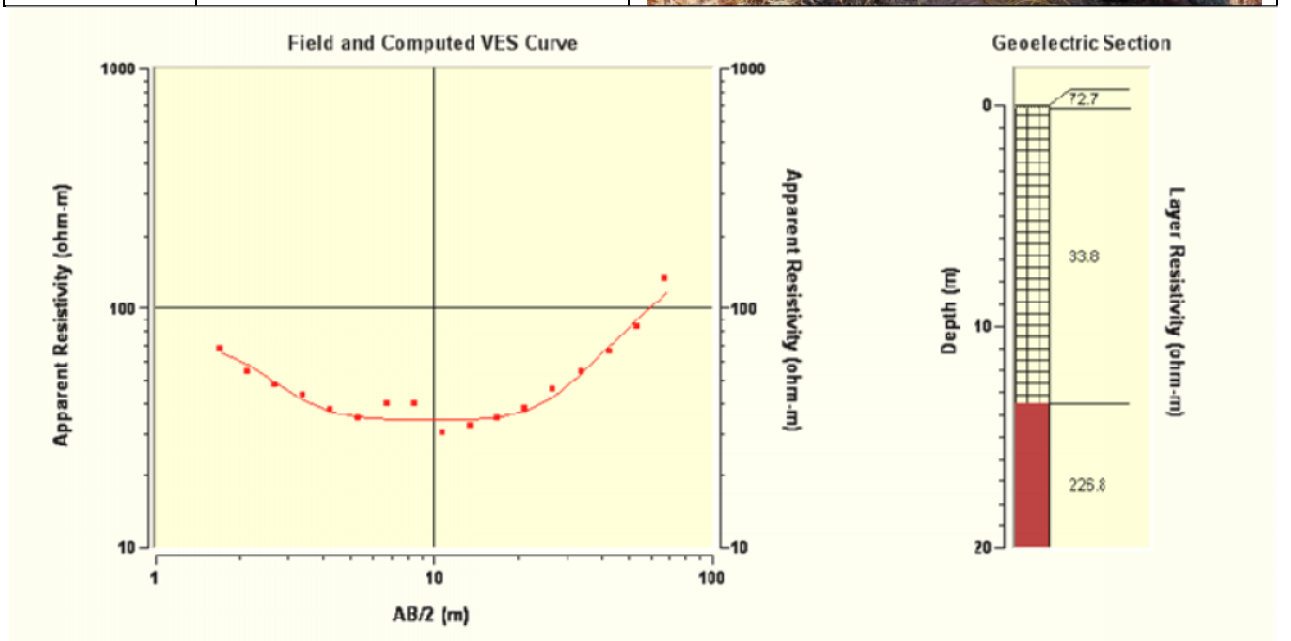

| **VES No.02. Interpretation by log log sheet** | | | | |
|---|---|---|---|---|
| **A Resistivity (Ohm-M)** | **Thickness (M)** | **Depth (M)** | **Formation** | **Litholog** |
| 53.75 | 1.5 | | Top Soil clay with kankar | |
| 134.37 | 0.9 | 1.5 | Moist clay with kankar | |
| 53.3 | 12.8 | 2.4 | Saturated weathered/fractured gneiss | |
| 310 | 6.4 | 15.2 | Semi Weathered or un weathered granite gneiss rock | |
| 122.5 | - | 21.6 | Weathered/fractured gneiss | |
| Total depth | | 21.6 | Hard rock granite | |
| **Recommendations:** Good aquifer expected for drinking purpose. Expected depth of drilling is at about 60±5m. | | | | |

| | |
|---|---|
| **VES No.** | **03** |
| Gram Panchayat | Thuapadar |
| Village | Thuapadar |
| Place | Near Nilkantheswar Temple |
| GPS Location | N 19$^0$ 59' 55.87"<br>E 83$^0$ 09' 52.22" (226m) |
| Beneficiaries | 30 Families |




| VES No.03. Interpretation by log log sheet | | | | |
|---|---|---|---|---|
| **A Resistivity (Ohm-M)** | **Thickness (M)** | **Depth (M)** | **Formation** | **Litholog** |
| 9.4 | 2 | | Top Soil clay with kankar | |
| 18.8 | 3.4 | 2 | Moist clay with kankar | |
| 85 | 3 | 5.4 | Saturated weathered/fractured gneiss | |
| 450 | 10.5 | 8.4 | Un weathered or massive rock | |
| Total depth | | 18.9 | Massive rock granite | |
| **Recommendations:** Moderate aquifer for drinking purpose. Exp. Depth of drilling is about 40±5 | | | | |

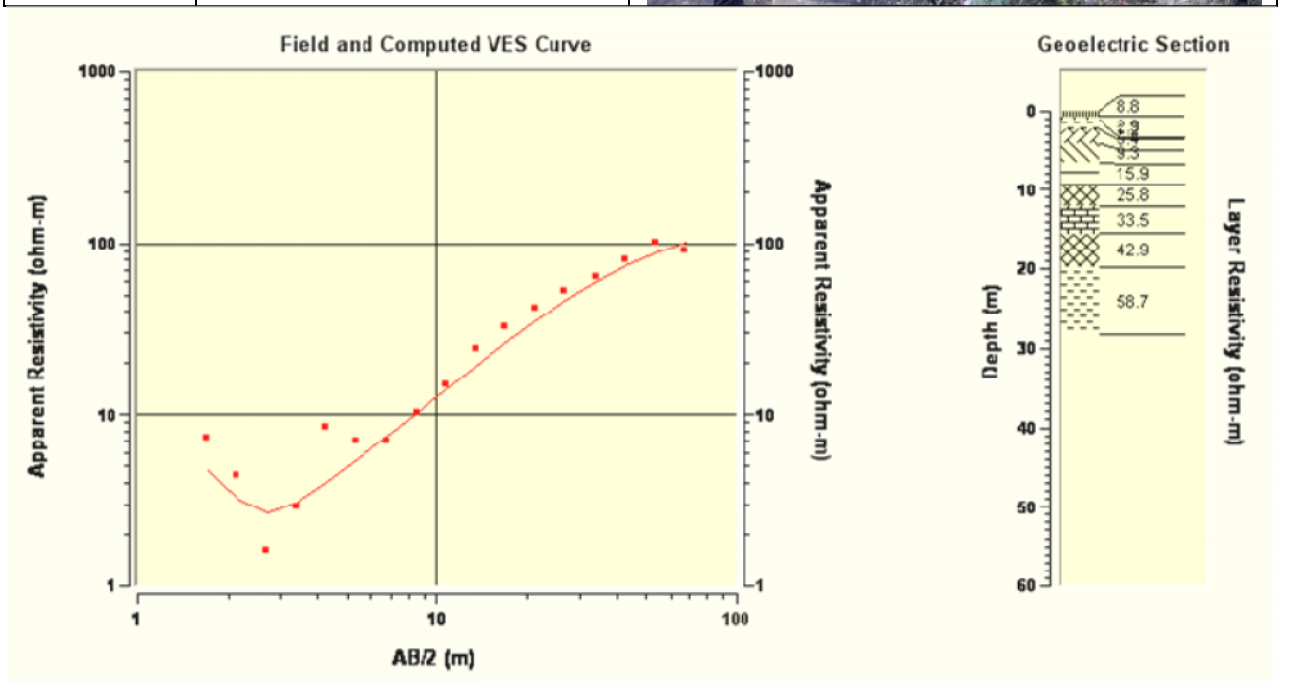
| | |
|---|---|
| **VES No.** | **04** |
| Gram Panchayat | Bhatangpadar |
| Village | Kinkhola |
| Place | In land of Labo Manjhi |
| GPS Location | N $19^0$ 53' 00.92"<br>E $83^0$ 14' 32.54" (333m) |
| Beneficiaries | 30 Families |




| **VES No.04. Interpretation by log log sheet** | | | | |
|---|---|---|---|---|
| **A Resistivity (Ohm-M)** | **Thickness (M)** | **Depth (M)** | **Formation** | **Litholog** |
| 57.01 | 2 | | Top Soil clay with kankar | |
| 22.80 | 4 | 2 | Moist clay with kankar | |
| 48 | 15 | 6 | Weathered layer | |
| 294 | 16.1 | 21 | Weathered or fracture gneiss | |
| 630 | - | - | Massive rock granite | |
| Total depth | | 37.1 | Massive rock granite | |

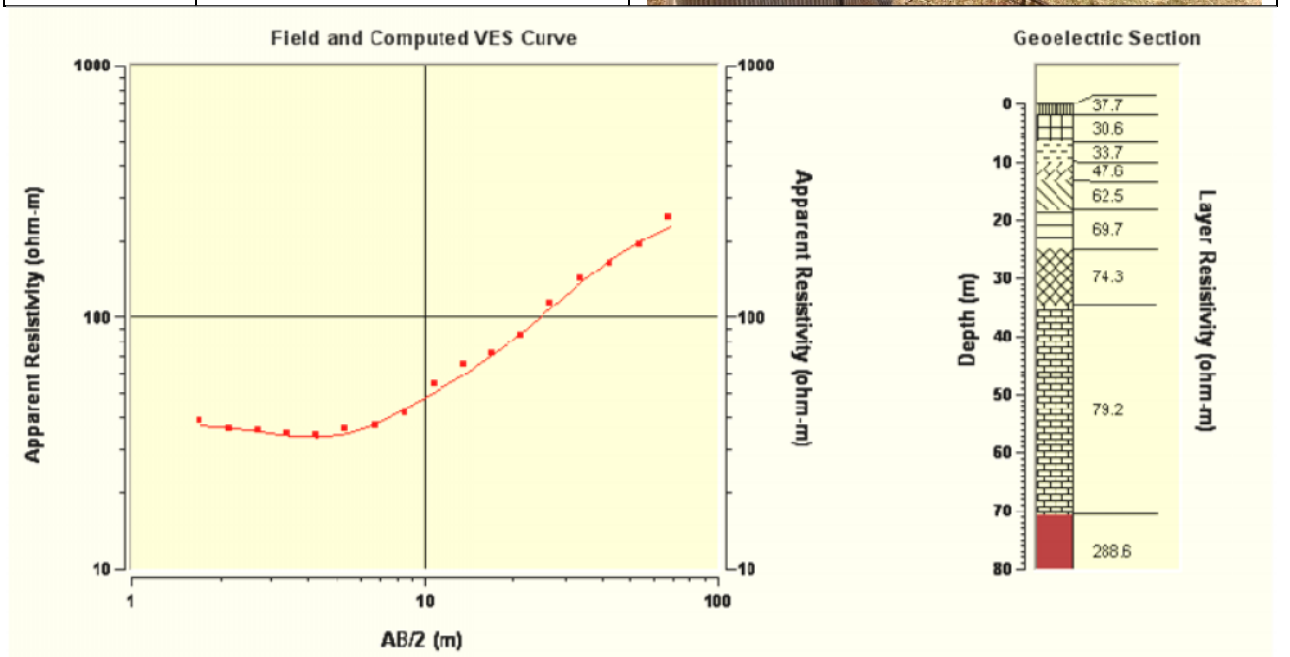
**Recommendations:** Moderate to Good aquifer for drinking purpose. Exp. Depth of drilling is about 75±5m to find out the good aquifer for water supply scheme.

| | |
|---|---|
| **VES No.** | **05** |
| Gram Panchayat | Thuapadar |
| Village | Bhimdanga |
| Place | In land of Laxman Goud |
| GPS Location | N $19^0$ 59' 23.29"<br>E $83^0$ 08' 47.41" (333m) |
| Beneficiaries | 30 Families |




| VES No.05. Interpretation by log log sheet | | | | |
|---|---|---|---|---|
| **A Resistivity (Ohm-M)** | **Thickness (M)** | **Depth (M)** | **Formation** | **Litholog** |
| 17.55 | 2 | | Top Soil clay with kankar | |
| 26.32 | 5 | 2 | Moist clay with kankar | |
| 87.5 | 5.6 | 7 | Weathered saturated layer | |
| 420 | 6 | 12.6 | Unweathered granite gneiss | |
| 1720 | - | - | Highly hard rock massive granite | |
| Total depth | | 18.6 | Highly hard rock massive granite | |
| **Recommendations:** Expected moderate aquifer for drinking purpose. Exp. Depth of drilling is about 50±5m | | | | |

| | |
|---|---|
| **VES No.** | **06** |
| Gram Panchayat | Thuapadar |
| Village | Bhimdanga |
| Place | In land of Khushi Ram Goud |
| GPS Location | N $19^0$ 59' 20.82"<br>E $83^0$ 08' 41.85" (333m) |
| Beneficiaries | 30 Families |




| VES No.05. Interpretation by log log sheet | | | | |
|---|---|---|---|---|
| **A Resistivity (Ohm-M)** | **Thickness (M)** | **Depth (M)** | **Formation** | **Litholog** |
| 40.75 | 1.5 | | Top Soil clay with kankar | |
| 26.748 | 2.5 | 1.5 | Moist clay with kankar | |
| 105 | 10.8 | 4 | Weathered or fracture layer | |
| 780 | 10.8 | 14.8 | Massive rock granite | |
| Total depth | | 25.65 | Massive rock granite | |

**Recommendations:** Expected moderate aquifer for drinking purpose. Exp. Depth of drilling is about 50±5m.

| Table 3. VES Summary | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| VES No. | *Village* | *Apparent Resistivity in (Ωm) ohm-meters.* | | | | | *Thickness in (m) meters* | | | |
| | | *ρ1* | *ρ2* | *ρ3* | *ρ4* | *ρ5* | *h1* | *h 2* | *h3* | *h4* |
| 1 | ***Kanakpur-Harijan Pada*** | 23.8 | 15.47 | 105 | 322 | - | 1.5 | 12 | 18.2 | - |
| 2 | ***Katyanipur*** | 53.75 | 134.37 | 53.3 | 310 | 122.5 | 1.5 | 0.9 | 12.8 | 6.4 |
| 3 | ***Thuapadar*** | 9.4 | 18.8 | 85 | 450 | - | 2 | 3.4 | 3.0 | 10.5 |
| 4 | ***Kinkhola*** | 57.01 | 22.80 | 48 | 294 | 630 | 2 | 4 | 15 | 16.1 |
| 5 | ***Bhimdanga*** | 17.55 | 26.32 | 87.5 | 420 | 1720 | 2 | 5 | 5.6 | 6.0 |
| 6 | ***Bhimdanga*** | 40.75 | 26.748 | 105 | 780 | - | 1.5 | 2.55 | 10.8 | 10.8 |

**7.3. Technical Findings:** According to the results of the resistivity survey carried out in the project area, the geo-electrical pseudo-sections analysis is now reach to the following conditions:

- The resistivity values were decreased towards the center of the area due to decreasing grain size, pores and permeability of the strata.
- The low resistivity anomalies were extended in the middle depth of geo-electrical sections under the ground due to influence of groundwater.
- The resistivity values were increased in more depth due to presence of massive bed rock with high resistivity.
- The lowest resistivity values were observed in weathered fractures or saturated zones.
- The 1st layer was interpreted to be near surface layer and had highly variable resistivity ranges. The 2nd was dry weathered layer with pebble formation with thickness of more than surface layer. The 3rd geo-electrical layer that corresponded to the weathered/fracture saturated layer having resistivity range between 80-400 Ω m. The 4th layer becomes bedrock and some time it may also be semi weathered or fracture condition. 5th layer becomes massive hard bed rocks with very high resistivity range more than 400 Ω m where no aquifer is encountered under the strata.
- The Study area comes under ***moderate groundwater provenance.***
- Groundwater aquifer occurs under water table /semi confined and unconfined conditions
- The weathered and fractured granite gneiss formation forms the main water bearing zones in the area.
- Recharge of groundwater source is low and runoff is high because of undulating topography of the area.
- Based on the analysis of the Geo-electric curves, groundwater resources of the investigated area are not much satisfactory and not guaranteed for the muddy-slush (sludge) and pebbly sandstone of collapsible zone below the underground water bearing rock strata.
- *Though due care has been taken in conducting groundwater survey, results cannot be guaranteed as this is an indirect method of subsurface investigation.*

**8. RECOMMENDATIONS:** Based on the above hydro-geological investigation and geophysical survey & data interpretation, following recommendation rendered for drilling installation of Tube Well for drinking purpose.

**Table 4. Recommendations**

| VES No. | *Gram Panchayat* | *Village* | *Location* | *Remarks* | *Exp. Depth of Drilling (m)* |
|---|---|---|---|---|---|
| 1 | Siripur | Kanakpur-Harijan Pada | In land of Parthav Nayak | Moderate to Good | 50±5 |
| 2 | Medinipur | Katyanipur - Bhawanipur | In land of Jogeswar Manjhi/Kashi Manjhi | Good | 60±5 |
| 3 | Thuapadar | Thuapadar | Near Nilkantheswar Temple | Moderate | 40±5 |
| 4 | Bhatangpadar | Kinkhola | In land of Labo Manjhi | Moderate to Good | 75±5 |
| 5 | Thuapadar | Bhimdanga | In land of Laxman Goud | Moderate | 50±5 |
| 6 | Thuapadar | Bhimdanga | In land of Khushi Ram Goud | Moderate | 50±5 |

*Note: VES-No. 2 and 4 can be planned for water supply scheme after observation of good yield during drilling and within pumping test analysis.*

***8.1 Suggestions:***

Overall observation is confined that no any site is best feasible for supply of water for irrigation purpose. The only drinking purpose can be solved by these bore wells.

- Drilling is feasible at a distance of ½ to 1m average dia. from survey point.
- **4 ½ or 5** inch dia. And an on average **60±*5*** metre depth bore hole should be drilled at recommended sites by DTH drilling techniques. Flushing is necessary time to time due course of drilling. Casing should be installed against loose soil and highly weathered zone at 15-20m approx. In case of collapsible zone observed, slotted casing should be extending up to hard rock formation. Slight variation is possible in depth of drilling and installation of casing depending upon weathered/fracture litho-logical formation and findings of good aquifer under the strata.
- The result cannot be guaranteed in case of underground folding, faulting, tilting **and collapsible zone (muddy sludge strata)**; however in this type formation good aquifer can be found.
- Pumping test is required to know about the exact yield (lph/lpm) of ground water from drilled bore well.
- Water quality testing should be done before consuming the water in these areas because of acidic/basic nature of water quality.
- According to Geological and Hydro-geological strata under the crustal earth the occurrence of groundwater is not in very good condition and the groundwater table level goes down day by day due to overexploitation. To manage the groundwater table level groundwater recharging through roof water harvesting structures and other innovative techniques are the suitable measure to accept and apply.
- Follow Annexure for design & cost estimate.

**ANNEXURE-I**

Estimate for the drilling of 250mm x 125mm dia. x 180±10 feet depth with 60±10 feet U.P.V.C. casing pipe in hard rock formation for installation of IM-II Hand Pump including construction of 6 feet dia. round platform around the Tube well with 10 feet long drain in the Project area of ARO-Bhubaneswar.

| Line no. | Description | Quantity | Unit | Unit Price | Line Total |
|---|---|---|---|---|---|
| 1 | Transportation of Rig Machine, tools and equipments including all accessories etc. | 1 | LS | 1000.00 | 1000.00 |
| 2 | Drilling in all kinds of soils/rocks etc. by DTH drilling technique doing 127mm (5") dia bore hole including labour cost. | | | | 0 |
| 2a | up to 90 Feet depth b.g.l. | 90 | Feet | 110.00 | 9900.00 |
| 2b | beyond 90 Feet depth b.g.l. | 90 | Feet | 120.00 | 10800.00 |
| 3 | 127mm (5") dia. U.P.V.C. casing pipe (Ashirwad/Oriplast/……..) or equivalent (length 10' and weight12 Kg.) | 50 | Feet | 216.00 | 10800.00 |
| 4 | 127mm (5") dia.U.P.V.C. casing pipe (Ashirwad/Oriplast/……..) slotted or equivalent (length 10' and weight 12 Kg.) | 10 | Feet | 276.00 | 2760.00 |
| 5 | Supplying all labours, tools & equipments for washing & flushing of bore till clean and clear water discharge by Air Compressor. | 0.50 | Hr | 1200.00 | 600.00 |
| 6 | Installation charges of casing | 60 | Feet | 15.00 | 900.00 |
| 7 | Supplying all materials, labours, tools and equipments & doing Fitting and Fixing of..... | | | | 0.00 |
| 7a | IM-II Handpumps (heavy body) | 1 | No. | 3500.00 | 3500.00 |
| 7b | Column/delivery Pipe PVC (dia. 32mm, length 10') - (Ashirwad/Oriplast/……..) | 80 | Feet | 30.00 | 2400.00 |
| 7c | Riser - connecting rod (CI), | 80 | Feet | 15.00 | 1200.00 |
| 7d | Brass cylinder (Standard quality) - Brand…….. | 1 | No. | 900.00 | 900.00 |

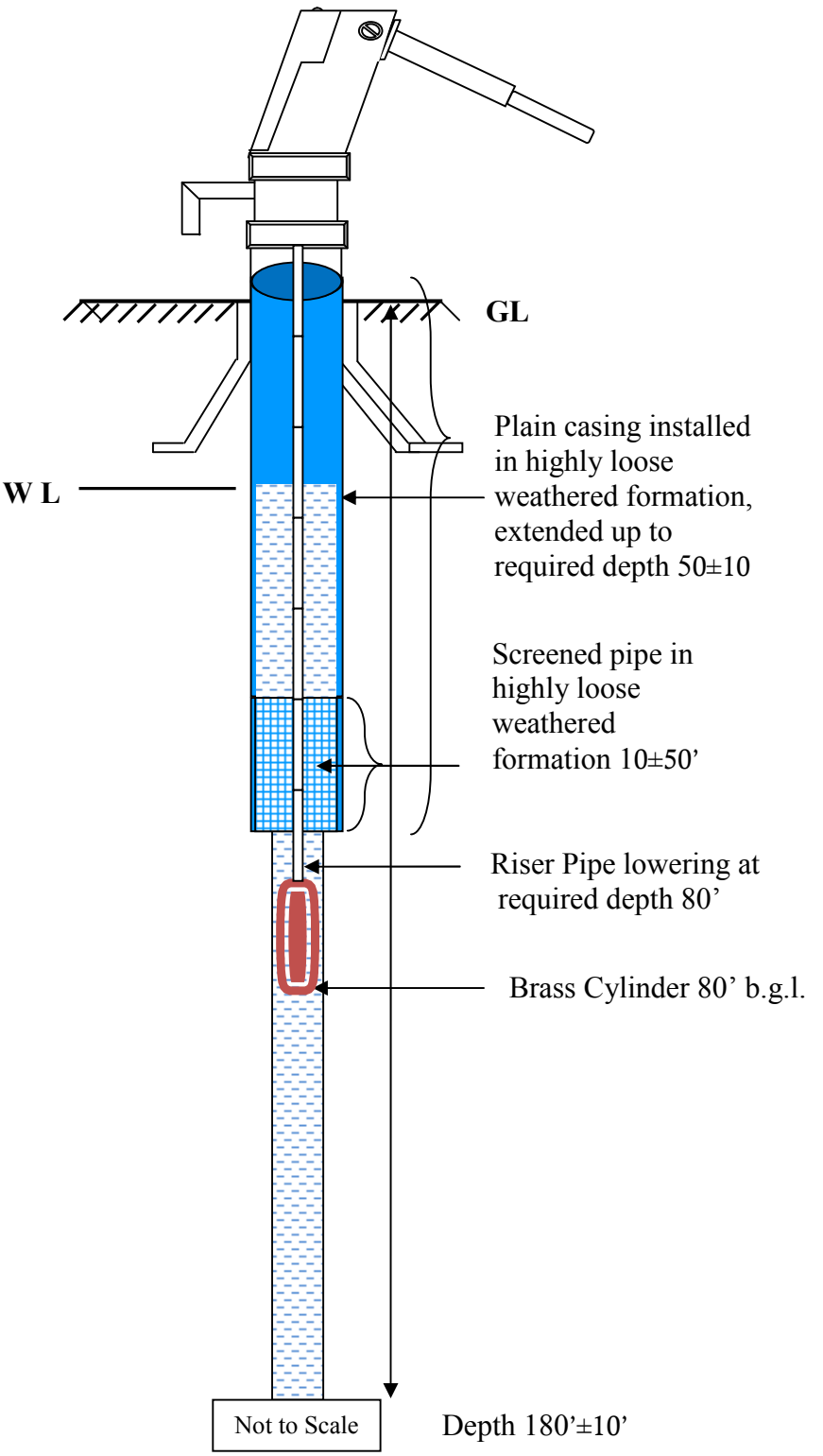
| | | | | | |
|---|---|---|---|---|---|
| 7e | Installation charges of above materials 7a to7d | 1 | LS | 1000.00 | 1000.00 |
| 8 | Construction of rounded (6' inner dia.) platform (UNICEF design), providing PCC in coping with nominal mix of 1:2:4 including labours, tools and equipments etc. | 1 | LS | 3500.00 | 3500.00 |
| 9 | Construction of drainage line (10' length) providing PCC in coping with nominal mix of 1:2:4 including labours, tools and equipments etc. | 1 | LS | 550.00 | 550.00 |
| 10 | Construction of **Recharge cum Soak Pit** (as per provided design) including labours, tools and equipments etc. | 1 | LS | 10196.00 | 10196.00 |
| | Accessories (if any) | | | | |
| | | | | **Sub Total** | **60006.00** |
| | Contingencies @ 3% | 3 | | **1800.00** | 1800.00 |
| | All GST @ 15% | 15 | | **9001.00** | 9001.00 |
| | Profit @ 10% | 10 | | 6001.00 | 6001.0 |
| | | | | **Total Cost** | **76808.00** |
| *Seventy six thousand eight hundred and eight only* | | | | | |

***Note:*** *Unit cost of the activity taken is in highest rate compared with market price. Cost will vary according to the quantities and qualities of product, depth of drilling and installation of casing b.g.l. i.e. 70,000.00 to 80,000.00.*

*Depth of drilling, installation of casing, time of washing & flushing for clean and clear water discharge, depth of installation of casing and fitting of delivery pipes with connecting rod, etc. The total budget may vary according to actual depth of drilling, utilisation of materials as per actual field conditions.*

**PVC:** *Plasticized Polyvinyl Chloride.* **UPVC:** ***unPlasticized Polyvinyl Chloride*** *often used for drainage and window frames. uPVC is tough durable plastic film that is not as flexible as PVC.*

# DESIGN FOR THE INSTALLATION OF NEW HAND PUMPS



## COST ESTIMATE FOR THE CONSTRUCTION OF SOAK PIT CUM RECHARGE PIT WITH CHAMBER & DRAINAGE LINE FOR HAND PUMP

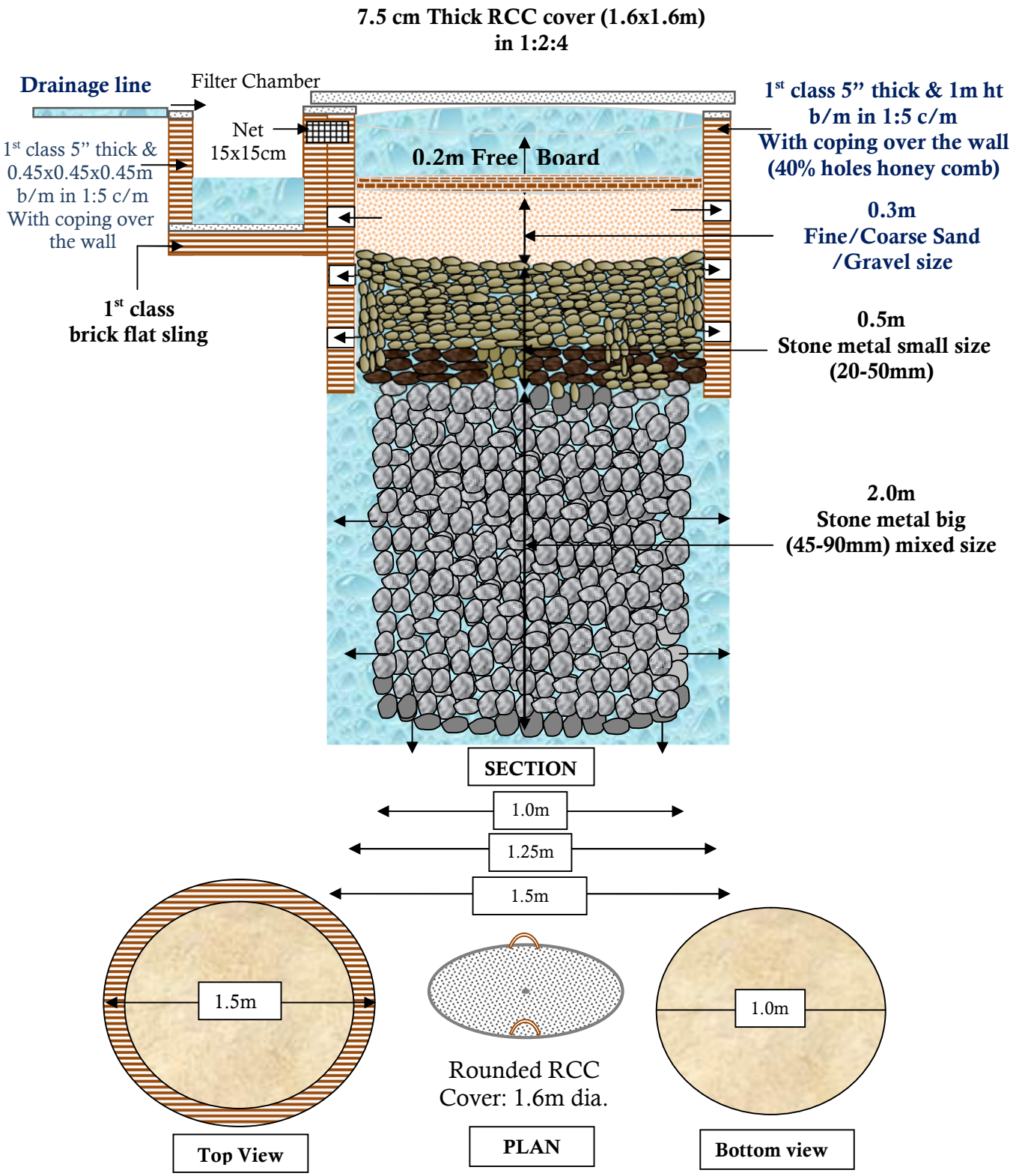
| Sl. No. | Item | Qty. (in cum) | Rate (unit) | Amount (in Rs.) |
|---|---|---|---|---|
| **1** | Excavation in foundation of soak pit with chamber in mixed soil (all kinds of soil moorum soil, soil mixed with kankar, pebbles and boulder up to 300mm size and disposal of the same beyond 50m away from the foundation work), including all lead and lifts as per complete work. | | | |
| i | For soak pit top (Outer dia =1.5m, D =1.00m) | 1.767 | | |
| ii | For soak pit bottom (Inner dia =1m, D=1m) | 0.785 | | |
| iii | For chamber (0.6m x 0.6m x 0.6m) | 0.216 | | |
| | Total E/W | 2.768 | 74.8176 | 207.09 |
| **2** | Flat 1st class brick soling on the chamber (0.6x0.6m) | 0.36 Sqm | 259.5384 | 93.43 |
| **3** | Brick masonry of work in designation with 75A brick with cement mortar 1:5 approved quality of clean coarse sand of F.M. 2 to 2.5 including providing 10mm. thick mortar joints. | | | |
| i | For chamber (2.3m x0.12m x0.45m) | 0.1242 | 3660.162 | 454.59 |
| ii | Top of soak pit (consisting 40% holes in honey comb brick work) | 0.324 | 3660.162 | 1185.89 |
| iii | 2.5cm thick PCC 1: 2 : 4 on the bottom of the chamber (0.45x0.45m) | 0.005 | 5080.284 | 25.40 |
| iv | 2.5cm Thick PCC coping on the chamber in 1:2:4 | 0.0054 | 5098.3416 | 27.53 |
| v | 2.5cm Thick PCC coping on the soak pit in 1:2:4 | 0.0135 | 5098.3416 | 68.82 |
| **4** | Providing 12mm cement Plastering on brick work & PCC of chamber in (1:4) with clean coarse sand of FM (1.5) including all materials, curing of water with all lead and lifts all complete work. | 1.316 Sqm | 115.3152 | 151.75 |
| **5** | Providing 1.5 mm cement punning including curing of water with all leads and lifts all complete work. | 1.316 Sqm | 37.8576 | 49.82 |
| **6** | Materials to be filled in soak pit | | | |
| i | Coarse sand, (0.3m thick) | 0.368 | 1398.4344 | 514.62 |
| ii | Stone metals coarse aggregate, (0.5m thick, size (22.8 mm to 53 mm) | 0.614 | 671.9988 | 412.60 |
| iii | Stone metals coarse aggregate, 2.00m thick (45mm to 90mm) | 1.57 | 544.6452 | 855.09 |
| iv | Net (plastic or wire mesh 5mm dia. 15cm x 15cm) | 1 | 220 | 220 |
| **7** | Construction of RCC slab cover for soak pit | | | |
| i | 7.5cm thick RCC slab in (1:2:4) 1.6x1.6m (in three block) | 0.192 | 5080.284 | 975.41 |

| | | | | |
|---|---|---|---|---|
| ii | 8mm Diameter TMT bar with wire | 21 | 79.2 | 1663.20 |
| **8** | Construction of drainage line for 3m length | | | |
| i | Site cleaning and proper leveling as per requirement | 1 | 110 | 110.00 |
| ii | 1st class brick flat soling (3.0x0.38m) | 1.14 Sqm | 259.5384 | 295.87 |
| iii | Single brick masonry work in 1:5 cement mortar | 0.054 | 3660.162 | 197.648 |
| iv | Providing 12mm cement Plastering on (inner, top & outer side 5cm width) in 1:4 with clean coarse sand of FM (1.5) including all materials & labour required for proper completion of work. | 1.68 sqm | 115.3152 | 193.72 |
| v | Providing 1.5 mm neat cement punning including curing of water with all complete work | 1.68 sqm | 37.8576 | 63.60 |
| **9** | Moorum soil required for filling around the drainage line & soak with chamber pit | | | |
| i | Supplying moorum soil (local) with carriage & including all taxes etc. | 2 | 495 | 990.00 |
| | | (-5.66) | | |
| ii | Supplying equipment and labour for moorum filling around drainage line & soak pit with chamber | 5.66 | 47.19 | 267.09 |
| | **Sub total** | | | 9023.23 |
| 10 | Carriage cost @ 10% | | | 902.32 |
| 11 | Contingency cost @3% | | | 270.69 |
| | **Total Cost** | | | 10196.26 |
| Rs. Ten thousand one hundred and ninety six only | | | | |

## Materials Required

| S.N. | Particulars | Quantity | Unit |
|---|---|---|---|
| | **For construction work** | | |
| 1. | Brick | 260 | Nos. |
| 2. | Cement | 3 | bags |
| 3. | Sand | 0.726 | Cum |
| 4. | Coarse aggregates (chips) | 0.194 | Cum |
| | **For filling materials** | | |
| 5. | Coarse Sand | 0.368 | Cum |
| 6. | Coarse aggregates (small size) | 0.614 | Cum |
| 7. | Coarse aggregates (big size) | 1.57 | Cum |

# DESIGN FOR THE CONSTRUCTION OF SOAK PIT CUM RECHARGE PIT WITH CHAMBER & DRAINAGE LINE



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**Abbreviations:**

b.g.l. : below ground level

m.s.l. : Mean Sea Level

PWL : present water level

GW : Groundwater

HP : Hand Pump

BW : bore well

DW : dug well

SWL : Static Water Level